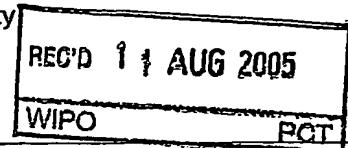


PATENT COOPERATION TREATY
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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference MASB/P30636PC	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/GB2004/001846	International filing date (day/month/year) 29.04.2004	Priority date (day/month/year) 29.04.2003
International Patent Classification (IPC) or national classification and IPC G05D1/08		
Applicant MASS CONSULTANTS LIMITED et al.		

<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> (<i>sent to the applicant and to the International Bureau</i>) a total of 12 sheets, as follows:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions). <input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box. <p>b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)), containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>

<p>4. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Box No. I Basis of the opinion <input type="checkbox"/> Box No. II Priority <input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability <input type="checkbox"/> Box No. IV Lack of unity of invention <input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement <input type="checkbox"/> Box No. VI Certain documents cited <input type="checkbox"/> Box No. VII Certain defects in the international application <input type="checkbox"/> Box No. VIII Certain observations on the international application

Date of submission of the demand 29.11.2004	Date of completion of this report 09.08.2005
Name and mailing address of the International preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Helot, H Telephone No. +49 89 2399-2287



**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/GB2004/001846

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
 - This report is based on translations from the original language into the following language, which is the language of a translation furnished for the purposes of:
 - international search (under Rules 12.3 and 23.1(b))
 - publication of the international application (under Rule 12.4)
 - international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

Description, Pages

1, 3, 5-44	as published
2, 4	received on 30.11.2004 with letter of 29.11.2004

Claims, Numbers

1-66	received on 22.04.2005 with letter of 22.04.2005
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Drawings, Sheets

1/10-10/10	as published
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a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. The amendments have resulted in the cancellation of:
 - the description, pages
 - the claims, Nos.
 - the drawings, sheets/figs
 - the sequence listing (*specify*):
 - any table(s) related to sequence listing (*specify*):
4. This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
 - the description, pages
 - the claims, Nos.
 - the drawings, sheets/figs
 - the sequence listing (*specify*):
 - any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/GB2004/001846

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	13-15,20-22,24,26,28-33,38,40,42,44, 46,53,55,58,61,63-66
	No: Claims	1-12,16-19,23,25,27,34-37,39,41,43,45, 47-52,54,56,57,59,60,62
Inventive step (IS)	Yes: Claims	
	No: Claims	1-66
Industrial applicability (IA)	Yes: Claims	1-66
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(SEPARATE SHEET)**

International application No.

PCT/GB2004/001846

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1 Reference is made to the following documents:

- D1 : US R E37 331 E (SCHROEDER WAYNE K) 14 August 2001
- D2 : EP 0 747 655 A (HUGHES MISSILE SYSTEMS) 11 December 1996
- D3 : US 4 598 888 A (BETEILLE ROGER H) 8 July 1986
- D4 : US 3 734 432 A (LOW G) 22 May 1973

2 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1, 31 and 32 is not new (Article 33(2) PCT).

2.1 Document D1 discloses a control system for a craft having an aft control device made up of fins and a forward control device made up of canards (14) (see column 1, lines 36-47 and the combination of claims 2,6 and 7). Thus, two wing control surfaces spaced apart along a main body section of the craft are disclosed. The system further comprises automated synchronized operation of the two wing control surfaces for continuous variable displacement for manoeuvre of the main body (see column 4, lines 31 to 58).

Document D1 further discloses the control of the transverse acceleration (see column 4, line 40 to 58). Since the transverse acceleration is related to the angle of attack (see column 2, line 10 to 18), the control system of document D1 is suitable for manoeuvre of the main body relative to the flight path velocity vector with control to a predetermined angle of attack.

Hence all the features defined in claim 1 are disclosed in document D1. Consequently, the subject-matter of claim 1 is not new (Article 33(2) PCT).

2.2 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 32 which therefore is also considered not new (Article 33(2) PCT).

2.3 Document D1 discloses a craft having a system of control according to claim 1. Thus, the subject-matter of claim 31 is not new (Article 33(2) PCT).

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(SEPARATE SHEET)**

International application No.
PCT/GB2004/001846

2.4 Independent claim 62 is directed to a craft having a method of control according to claim 32. Since a craft is an apparatus, it should be characterized by apparatus features instead of method steps. Thus, claim 62 is not clear (Article 6 PCT). A clarified claim 62 would substantially correspond to present claim 31 and would not meet the requirements of Article 33(2) PCT.

3 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 63 to 66 does not involve an inventive step in the sense of Article 33(3) PCT.

3.1 Concerning claims 63 and 64, document D1 relates to a craft which is usually controlled by computer. Therefore, it is obvious to load a computer program into an internal memory for performing the methods of control that these documents disclose. Thus, the subject-matter of claims 63 and 64 lacks an inventive step (Article 33(3) PCT).

3.2 Claim 65 has been read as referred back to claim 63 instead of claim 62. For analog reasons as for claims 63 and 64 the subject-matter of claims 65 and 66 lacks an inventive step (Article 33(3) PCT).

4 The disclosure of documents D2 to D4 affects novelty and inventive step of the independent claims 1,31,32 and 62 to 66 in the same manner as document D1.

5 Dependent claim 2-30 and 33-61 do not appear to contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step.
The additional features of dependent claims 2-30 and 33-61 do not appear to provide significant distinction over the prior art.
The features defined in dependent claims 2-12, 16-19, 23, 25, 27, 34-37, 39, 41, 43, 45, 47-52, 54, 56 and 57 are disclosed in one or more of documents D1 to D4. Thus, the subject-matter of these claims is not new (Article 33(2) PCT).
It does not appear that the subject-matter of dependent claims 13-15, 20-22, 24, 26, 28-33, 38, 40, 42, 44, 46, 53, 55 and 58-61 contain any features which, in combination with the features of any claim to which they refer, meet the requirements

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(SEPARATE SHEET)**

International application No.

PCT/GB2004/001846

of the PCT in respect of inventive step (Article 33(3) PCT).

lifting surface flaps is intended to do away with the need for a tailplane thereby offering the prospect of a shorter length aircraft than usual.

5 GB Patent Specification No. 547,397 involves a tandem wing aircraft and tailplane with elevator control. The two forward wing surfaces are mechanically linked through the pilot control column to achieve a differential pitch deflection as the pilot control column is moved forward and aft. The objective is the reduction of aircraft width and length through the use of the tandem wing arrangement.

10 The tandem wing arrangement is mechanically actuated to provide a fixed geared rotation of both forward and aft wing surfaces. This gearing ratio is fixed on the ground by mechanical adjustment of the control linkage rods attached to each wing and the control column and as such is a fixed discrete 15 method of control.

Summary of the Invention

According to the present invention, there is provided a control system for a 20 craft having two wing control surfaces spaced apart along a main body section of the craft, the system comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement for manoeuvre of the main body relative to the flight path velocity vector with body directional control.

25 The control system of the present invention may include any one or more of the following preferred features:-

- automated synchronised operation provides identical rotational and/or translational movement of the two control surfaces;

zero lift line. Fully moving surfaces are in keeping with missile methods of control.

In cases where the wing and tail is fixed to the body with only a trailing edge flap offering control, the lifting surface to which it is attached experiences a local change in zero lift line similar to that for a fully moving surface as the flap is deflected. If both the wing and tail surface comprise trailing edge flaps, then there is again an overall body change in zero lift line due to the combined effect of deflecting one or both sets of controls in any order. Lifting surfaces, whether acting as a wing or tail surface which operate a trailing edge flap, are more in keeping with UAV's and civil/military aircraft.

15 · The present invention also provides a craft having a control system of the
present invention.

According to the present invention, there is also provided a method of controlling a craft having two wing control surfaces spaced apart along a main body section of the craft, the method comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement for manoeuvre of the main body relative to the flight path velocity with body directional control.

The method may include any one or more of the following preferred features:-

- automated identical rotational and/or translational movement of the main and secondary control surfaces;
- automated proportional rotational and/or translational movement of the main and secondary control surfaces;

CLAIMS

1. A control system for a craft having two wing control surfaces spaced apart along a main body section of the craft, the system comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement in flight for manoeuvre of the main body relative to the flight path velocity vector with control to a predetermined angle of attack.
2. A control system according to Claim 1, comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement in flight for manoeuvre of the main body relative to the flight path velocity vector with control to a predetermined angle of attack and attitude relationship.
3. A control system for a craft according to Claim 1 or 2 comprising means for automated synchronized operation of the two wing control surfaces to maintain continuous variable displacement of each wing control surface via independent actuation under the action of a control routine.
4. A control system for a craft according to any preceding claim comprising means for independent actuation of both wings under a control routine involving a soft actuation mechanism.
5. A control system for a craft according to any preceding claim comprising means for a demand manoeuvre to act along an axis normal to a Zero Lift Line and in the plane of manoeuvre.
6. A control system for a craft according to Claim 5 wherein the Zero Lift Line is that line co-incident with the local wind axis velocity vector,

acting in the plane of manoeuvre in which the two wing control surfaces are deflected and about which there is no net normal force and moment.

7. A control system for a craft according to any of Claims 1 to 6 comprising means to manoeuvre comprising additional automated synchronized control deflection of both wings acting normal to the Zero Lift Line in the plane of manoeuvre under the action of a control routine.
8. A control system for a craft according to any of Claims 1 to 7 in which substantially all of a wing control surface is moveable under control actuation.
9. A control system for a craft according to any of Claims 1 to 8 comprising an additional flap portion of a moving wing control surface for control.
10. A control system for a craft according to any of Claims 1 to 9 wherein the craft is an aircraft, marine craft or UAV and wherein the control routine is operable to continually control both wing control surfaces to manoeuvre the craft for optimal fuel efficiency.
11. A control system for a craft according to any of Claims 1 to 10 wherein the craft is an aircraft, marine craft or UAV and wherein the control routine is operable to continually control both wings control surfaces to manoeuvre the craft to maintain optimal forward directional visibility.
12. A control system for a craft according to any of Claims 1 to 9 wherein the craft is a guided missile or torpedo in which the control routine is operable to continually position the manoeuvring main body at an angle

of incidence to the flight path velocity vector for optimal homing onto a target.

13. A control system for a craft according to any of Claims 1 to 9 where the craft is a guided missile or torpedo in which the control routine is operable to drive the manoeuvring main body axis to coincide with the flight path velocity vector to achieve zero angle of incidence (zero grazing incidence) at target impact for maximum warhead effectiveness.
14. A system according to any preceding claim wherein automated synchronised operation provides identical rotational and/or translational movement of the two wing control surfaces.
15. A system according to any preceding claim wherein automated synchronised operation provides proportional rotational and/or translational movement of the two wing control surfaces.
16. A system according to any preceding claim wherein automated synchronised operation provides geared rotational and/or translational movement of the two wing control surfaces.
17. A system according to any preceding claim wherein automated synchronised operation provides variable rotational and/or translational movement of the two wing control surfaces.
18. A system according to any preceding claim wherein the craft comprises more than two wing control surfaces.

19. A system according to any preceding claim wherein substantially all of a control surface is moveable under the automated synchronised operation.
- 5 20. A system according to any preceding claim wherein a flap portion of a wing control surface is moveable under the automated synchronised operation.
- 10 21. A system according to any of Claims 1 to 11 and 14 to 20 wherein the craft comprises an aircraft.
22. A system according to any of Claims 1 to 11 and 14 to 20 wherein the craft comprises a marine craft.
- 15 23. A system according to any of Claims 1 to 9 and 12 to 20 wherein the craft comprises a missile.
24. A system according to any of Claims 1 to 9 and 12 to 20 wherein the craft comprises a torpedo.
- 20 25. A system according to any preceding claim wherein the craft is unmanned.
26. A system according to any preceding claim comprising means to off-set the body axis relative to the instantaneous flight path velocity vector.
- 25 27. A system according to any preceding claim comprising means to effect an applied manoeuvre about an instantaneous Zero Lift Line.

28. A system according to any preceding claim comprising means to maintain constant speed V.
29. A system according to any preceding claim comprising means to adjust, at an instant in time, the control surfaces setting to effect configuration of the Zero Lift Line and initiate manoeuvre relative to the Zero Lift Line in any plane of manoeuvre.
30. A system according to any preceding claim having a controller to provide, selectively as required:-
 - constant speed;
 - variable speed;
 - proportional rotation and/or translation movement of control surfaces under independent actuation;
 - 15 geared rotational and/or translational movement of control surfaces under independent actuation;
 - variable rotational and/or translational movement of control surfaces under independent actuation.
- 20 31. A craft having a control system according to any one or more of Claims 1 to 30.
32. A method of controlling a craft having two wing control surfaces spaced apart along a main body section of the craft, the method comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement in flight for manoeuvre of the main body relative to the flight path velocity vector with control to a predetermined angle of attack.

30

33. A control system according to Claim 1, comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement in flight for manoeuvre of the main body relative to the flight path velocity vector with control to a predetermined angle of attack and attitude relationship.

34. A method of controlling a craft according to Claim 32 or 33 comprising automated synchronized operation of the two wing control surfaces to maintain continuous variable displacement of each wing via independent actuation under the action of a control routine.

35. A method of controlling a craft according to any of Claims 32 to 34 independent actuation of both wings under a control routine and involving operation of a soft actuation mechanism.

36. A method of controlling a craft according to any of Claims 32 to 35 comprising a demand manoeuvre acting along an axis normal to a Zero Lift Line and in the plane of manoeuvre is implemented.

37. A method of controlling a craft according to Claim 36 the Zero Lift Line is that line co-incident with the local wind axis velocity vector, acting in the plane of manoeuvre in which the two wings are deflected and about which there is no net normal force and moment.

38. A method of controlling a craft according to any of Claims 32 to 36 comprising additional automated synchronized control deflection of both wings acting normal to the Zero Lift Line in the plane of manoeuvre under the action of a control algorithm.

39. A method of controlling a craft according to any of Claims 32 to 38 comprising moving substantially all of a wing control surface under control actuation.

5 40. A method of controlling a craft according to any of Claims 32 to 39 comprising moving an additional flap portion of a wing control surface for control.

10 41. A method of controlling a craft according to any of Claims 32 to 40 wherein the craft is an aircraft, marine craft or UAV and comprising continually controlling both wing control surfaces to manoeuvre the craft for optimal fuel efficiency.

15 42. A method of controlling a craft according to any of Claims 32 to 40 wherein the craft is an aircraft, marine craft or UAV and comprising continually controlling both wing control surfaces to manoeuvre the craft for optimal forward directional visibility.

20 43. A method of controlling a craft according to any of Claims 32 to 40 wherein the craft is a guided missile or torpedo and comprising continually positioning the manoeuvring main body at an angle of incidence to the flight path velocity vector for optimal homing onto a target.

25 44. A method of controlling a craft according to any of Claims 32 to 40 wherein the craft is a guided missile or torpedo and comprising driving the manoeuvring main body axis to coincide with the flight path velocity vector for zero angle of incidence (zero grazing incidence) at target impact for maximum warhead effectiveness.

45. A method of controlling according to any of Claims 32 to 44 wherein automated synchronised operation provides identical rotational and/or translational movement of the two wing control surfaces.

5 46. A method of controlling according to any of Claims 32 to 45 comprising automated synchronised operation to provide proportional rotational and/or translational movement of the two wing control surfaces.

10 47. A method of controlling according to any of Claim 32 to 46 comprising automated synchronised operation to provide geared rotational and/or translational movement of the two wing control surfaces.

15 48. A method of controlling according to any of Claims 32 to 47 comprising automated synchronised operation to provide variable rotational and/or translational movement of the two wing control surfaces.

49. A method of controlling according to any of Claims 32 to 48 comprising moving more than two wing control surfaces.

20 50. A method of controlling according to any of Claims 32 to 49 comprising moving substantially all of a control surface moveable under the automated synchronised operation.

51. A method of controlling according to any of Claims 32 to 49 comprising moving a flap portion of a wing control surface under the automated synchronised operation.

25 52. A method of controlling according to any of Claims 32 to 42 and 45 to 51 wherein the craft comprises an aircraft.

53. A method of controlling according to any of Claims 32 to 42 and 45 to 51 wherein the craft comprises a marine craft.

54. A method of controlling according to any of Claims 32 to 40 and 43 to 51 or 52 wherein the craft comprises a missile.

55. A method of controlling according to any of Claims 32 to 40 and 43 to 51 or 53 wherein the craft comprises a torpedo.

10 56. A method of controlling according to any of Claims 32 to 55 wherein the craft is unmanned.

15 57. A method of controlling according to any of Claims 32 to 56 comprising off-setting the body axis relative to the instantaneous flight path velocity vector.

20 58. A method of controlling according to any of Claims 32 to 57 comprising effecting an applied manoeuvre about an instantaneous Zero Lift Line.

59. A method of controlling according to any of Claims 32 to 58 comprising maintaining constant speed V.

25 60. A method of controlling according to any of Claims 32 to 59 comprising adjusting, at an instant in time, the control surfaces setting to effect configuration of the Zero Lift Line and initiate manoeuvre relative to the Zero Lift Line in any plane of manoeuvre.

61. A method of controlling according to any of Claims 32 to 60 comprising operating a controller to provide, selectively as required:-

constant speed;

variable speed;

proportional rotation and/or translation movement of control surfaces under independent actuation;

5 geared rotational and/or translational movement of control surfaces under independent actuation;

variable rotational and/or translational movement of control surfaces under independent actuation.

10 62. A craft having a method of control according to any one or more of Claims 32 to 61.

15 63. A computer program product directly loadable into the internal memory of a digital computer, comprising software code portions for performing the method of any one or more of Claims 32 to 61 when said product is run on a computer.

20 64. A computer program directly loadable into the internal memory of a digital computer, comprising software code portions for performing the method of any one or more of Claims 32 to 61 when said program is run on a computer.

25 65. A carrier, which may comprise electronic signals, for a computer program of Claim 62.

66. Electronic distribution of a computer program product of Claim 63 or a computer program of Claim 64 or a carrier of Claim 65.

lifting surface flaps is intended to do away with the need for a tailplane thereby offering the prospect of a shorter length aircraft than usual.

5 GB Patent Specification No. 547,397 involves a tandem wing aircraft and tailplane with elevator control. The two forward wing surfaces are mechanically linked through the pilot control column to achieve a differential pitch deflection as the pilot control column is moved forward and aft. The objective is the reduction of aircraft width and length through the use of the tandem wing arrangement.

10

The tandem wing arrangement is mechanically actuated to provide a fixed geared rotation of both forward and aft wing surfaces. This gearing ratio is fixed on the ground by mechanical adjustment of the control linkage rods attached to each wing and the control column and as such is a fixed discrete method of control.

Summary of the Invention

According to the present invention, there is provided a control system for a craft having two wing control surfaces spaced apart along a main body section of the craft, the system comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement for manoeuvre of the main body relative to the flight path velocity vector with body directional control.

25

The control system of the present invention may include any one or more of the following preferred features:-

- automated synchronised operation provides identical rotational and/or translational movement of the two control surfaces;

zero lift line. Fully moving surfaces are in keeping with missile methods of control.

In cases where the wing and tail is fixed to the body with only a trailing edge flap offering control, the lifting surface to which it is attached experiences a local change in zero lift line similar to that for a fully moving surface as the flap is deflected. If both the wing and tail surface comprise trailing edge flaps, then there is again an overall body change in zero lift line due to the combined effect of deflecting one or both sets of controls in any order. Lifting surfaces, whether acting as a wing or tail surface which operate a trailing edge flap, are more in keeping with UAV's and civil/military aircraft.

The present invention also provides a craft having a control system of the present invention.

According to the present invention, there is also provided a method of controlling a craft having two wing control surfaces spaced apart along a main body section of the craft, the method comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement for manoeuvre of the main body relative to the flight path velocity with body directional control.

The method may include any one or more of the following preferred features:-

- automated identical rotational and/or translational movement of the main and secondary control surfaces;
- automated proportional rotational and/or translational movement of the main and secondary control surfaces;

CLAIMS

1. A control system for a craft having two wing control surfaces spaced apart along a main body section of the craft, the system comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement in flight for manoeuvre of the main body relative to the flight path velocity vector with control to a predetermined angle of attack.
2. A control system according to Claim 1, comprising automated synchronized operation of the two wing control surfaces for continuous variable displacement in flight for manoeuvre of the main body relative to the flight path velocity vector with control to a predetermined angle of attack and attitude relationship.
3. A control system for a craft according to Claim 1 or 2 comprising means for automated synchronized operation of the two wing control surfaces to maintain continuous variable displacement of each wing control surface via independent actuation under the action of a control routine.
4. A control system for a craft according to any preceding claim comprising means for independent actuation of both wings under a control routine involving a soft actuation mechanism.
5. A control system for a craft according to any preceding claim comprising means for a demand manoeuvre to act along an axis normal to a Zero Lift Line and in the plane of manoeuvre.
6. A control system for a craft according to Claim 5 wherein the Zero Lift Line is that line co-incident with the local wind axis velocity vector,

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